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MINERAL WEALTH

AND

Railroad Development.

A SERIES OF LETTERS

BY

J. W. FOSTER, LL. D.,

OF CHICAGO, ILL.

New York:
JOURNEYMEN PRINTERS' CO-OPERATIVE ASSOCIATION,
No. 30 Beekman Street.

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INTRODUCTION.

SINCE the publication in the New York Tribune of the series of letters addressed to that paper by Dr. J. W. Foster of Chicago, a wish has been generally expressed to have them brought together in a compact form. They have since undergone careful revision, material additions being made to them, so that their statements include particulars from the most recent and exact sources of information. As originally published, these letters attracted the favorable notice of the press throughout the country, and elicited highly appreciative expressions from eminent public men. It is hoped that in their present form they will furnish an available compendium of a class of recent facts, an acquaintance with which is essential to the correct comprehension of a vast industrial change destined to affect not only the region in which it is now taking place and the neighboring cities, but, ultimately, the manufacturing interests of the entire nation.

IN these letters it is shown beyond cavil that the location and peculiar qualities of the Block Coal of Indiana present a fortunate combination for industrial undertakings which cannot be elsewhere found. The coal-field is a level country of extraordinary agricultural fertility. At almost equal distances from its center there is a chain of

large commercial cities, situated at the north and east upon the great lakes, at the south and west on the Ohio and Mississippi Rivers. To furnish these cities with food, fuel and manufactures is the natural destiny of this central plain, which is capable of sustaining and giving employment to an immense population. The pure iron ores of Lake Superior are on one side of it, and those of Missouri on the other; and there is no other mineral fuel fit for smelting those ores to which they can be so readily conveyed by railroad. This coal and those ores, by their respective qualities, are perfectly fitted for manufacturing the best iron and Bessemer steel. There are thus combined in one locality, cheapness and nearness of raw materials, a singular suitableness of these for each other, markets that may be readily made accessible, and a steady demand for the product, since the uses of iron are increasing every day, and the hour is rapidly approaching when no American railway will be constructed except with home-made rails of Bessemer steel.

OF the result of developing these resources there can be no doubt. Cincinnati, five hundred miles nearer than Pittsburg to the iron ores of Missouri and Tennessee, and also as much nearer the Southern and Western markets for industrial products, should soon take precedence of that smoky city as a site of iron manufacture, since, while Pittsburg must send to Connelsville for a fuel that has to be coked before it is fit for the blast furnace, Cincinnati can have the mineral charcoal of the Block Coal Field at

hand as soon as one hundred and fifty miles of railroad are constructed over a level country. The growing towns in and near the coal region should be the sites of great manufacturing industries, prominent among which is to be the production of Bessemer steel. But it must be remembered that this mineral wealth—this prospective prosperity—will not, unaided, take any tangible form; it will lie where it has laid for ages, under the soil, making nobody one cent richer by the fact of its existence. To bring it to the surface and to convert it into real and personal estate—houses and city lots and manufacturing establishments—into active business and profitable industry, live enterprise is necessary; enterprise that puts its own shoulder to the wheel, instead of waiting for outside help. Railway development, connecting the coal-field with its markets, is all that is needed to inaugurate the new era of prosperity.

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LETTERS.

No. I.

Railroad Development of the Coal-Field.

INDIANA is rapidly assuming a front rank among the States of the Union She has hitherto been principally noted for her agricultural productions. It was well known that her soil was fertile, that her annual yield in corn and wheat was enormous, that she possessed a magnificent body of timber lands, and that her natural and artificial communications gave her free access to the markets of the world. But now she is entering upon another phase—that of a mining and manufacturing State. This change has been wrought by the discovery, in her coal-fields, of one or more seams of coal which have, in a crude state, all the properties of charcoal in reducing the iron ores, and bringing out a soft carbonaceous pig metal, susceptible of conversion into a tough malleable iron or into Bessemer steel. The latter is the severest test which can be applied to the various forms of fossil fuel. These peculiar coals, to which the term "block" has been applied, occur near the base of the Coal Measures, and can be traced, with occasional interruptions, all the way from the middle line of Fountain County (about 100 miles south of Lake Michigan) to the Ohio River—a distance of more than 150 miles—entirely within the State of Indiana. The Conglomerate, for the most part a heavy-bedded sandstone, which rests at the base of the coal-field, crops out in bold ledges, and gives to the country a broken contour. Hence, in projecting

the older railroads, this region was shunned, inasmuch as deep cuts and fills, as well as high grades and abrupt curves, were required. The projectors were ignorant of the inestimable wealth stored beneath the surface. Had, for instance, the Louisville, New Albany and Salem Railroad been located twenty miles further west, it would have rivaled the Reading Railroad in the amount of its freights, and its stock would have commanded the highest premium in the market, instead of being, as it now is, in the hands of a Receiver. It was but recently that the value of the block coals became known and appreciated. In 1867, the first furnace was built, and soon the erection of six others followed. The success of these furnaces, and the wide-spread demand for these coals as a domestic fuel, led to the organization of new lines of railway, some of which have been completed, while others are in the process of construction.

A brief enumeration of these roads, and of the markets which they are intended to supply, may not be out of place. The St. Louis, Vandalia and Indianapolis Railroad was constructed from commercial necessity, and without reference to the mineral wealth which was subsequently developed along its line. The Indianapolis and St. Louis Railroad, completed a little over a year ago, runs, so far as relates to the coal region, within cannon-shot of the former road. Instead of seeking to develop a new field, it boldly claimed to share with its rival in the traffic already developed. The Indianapolis, Bloomington and Western Railroad, opened within the last two years, crosses the coal belt in Fountain County, but thus far no collieries have been sufficiently developed to give to the road any substantial freight, although the indications are that the peculiar seam carrying the block coals has its outcrop in that vicinity. The Indiana North and South Railway, now constructing, will follow, very nearly, the outcrop of the block coals all the way from Bloomfield to Fountain County, and thence proceed to Chicago by a direct line. The Indiana and Illinois Central Railroad will cross the block coal belt in Parke County, and will give facilities for the distribution of this peculiar coal for a long distance east and west.

The Terre-Haute and Danville Railroad, forming intimate connections with the Chicago and Danville Road on the north, and

the Evansville and Crawfordsville Railroad on the south, affords a continuous route from the Lakes to the Ohio River. It has been built with express reference to the coal traffic, and hence all abrupt curves and steep grades have been avoided; and it is equipped with locomotives capable of drawing trains of forty cars. Its line is fifteen miles or more westward of the outcrop of the block coals, but it will receive its freights from the cross line centering at Terre-Haute.

The Vincennes and Indianapolis Railroad crosses the coal-field of Greene County diagonally, but unfortunately the block coal seam wedges out, or has been removed by drift agency in this vicinity; at all events no mine of that particular coal has been developed along its line.

The Indiana Mineral Railway will start at Bloomfield and strike the Ohio River near Troy, having special reference to the development of the magnificent splint coals in the eastern part of Spencer County, the best in the whole series of Indiana coals.

The Logansport, Crawfordsville and South-Western Railway, just completed, intersects the block coals on Sand Creek, in Parke County; and through the Detroit and Eel River, and the Toledo, Wabash and Great Western Railroads, will secure easy access to the ports on the west shore of Lake Erie. Detroit has her iron and copper-smelting works, and Toledo her iron works, which cannot fail to welcome this new source of supply of fossil fuel.

Last in the enumeration, but not least in importance, is the Cincinnati and Terre-Haute Railway, now in process of construction. Starting at the great commercial city of Ohio, it will traverse a rich agricultural country already dotted with farms, to Bessemer, on the White River, where it will bifurcate, one branch going to Terre-Haute, and another to or near Sullivan, intersecting the rich gas-coals, and thence to the Wabash River, where it will connect with the direct route of the St. Louis and Cincinnati Railway through the State of Illinois to St. Louis. It will cross the block coal region of the southern part of Clay County and the western part of Owen County, where the peculiar seam exhibits its widest expansion and its greatest thickness, and affords almost unequaled facilities for mining. It is confidently claimed by the projectors of this route, that the markets of Cincinnati and Louisville can be

as cheaply supplied with block coal as with the bituminous coals of Pittsburg and Youghiogheny, and that too without the possibility of a "coal famine," in case of a delay in the rising of the waters of the Ohio.

Thus, it will be seen that before the lapse of two years, the mining of these iron-smelting coals, instead of being restricted to a single district, as at present, will be spread over a zone of one hundred and fifty miles in extent; and it requires no prophetic vision to predict that, before the lapse of half a century, Indiana will rival Pennsylvania in the amount of her mineral products.

I propose in subsequent communications to describe the range and extent of the block coals, and their chemical and physical characteristics; the iron ores, their chemical composition and their accessibility to the coal, and the facilities for the distribution of their products over widely-separated regions. I was on the watershed between Lake Superior and Lake Michigan before the iron deposits, which now yield nearly 1,000,000 tons a year, were disturbed by a blast; I saw the Iron Mountain of Missouri before its sides were pierced, and when only a few hundred tons of loose fragments of ore were annually dug out of the ferruginous clay to supply two or three charcoal furnaces; and I was at Brazil, Indiana, when it was an indifferent railroad station, with a single shaft for the extraction of coal, which geologists passed by without heeding. In these matters, then, I speak not as a novice.

Terre-Haute, Ind., Dec. 4, 1871.

No. II.

Range and Extent of Indiana Coals.

I propose to give in this letter a brief outline of the coal-fields of Indiana, and the position which the block coals occupy in the assemblage of rocks which constitute the Coal Measures proper. Not less than twenty-four counties in South-Western Indiana are

underlaid wholly or in part by this series of rocks. The eastern margin of this coal-field may be thus defined: Starting at a point on the western boundary of the State, in Benton County—about seventy-five miles south of Lake Michigan—the line is protracted thence in a south-easterly direction to the mouth of Deer Creek, a few miles above Cannelton on the Ohio River. This is the eastern margin of the great Illinois coal-field, which stretches uninterruptedly westward to near the borders of the Mississippi River, and southward beyond the banks of the Ohio, comprehending two-thirds of the State of Illinois, and a considerable portion of Kentucky—the total area being not less than 60,000 square miles. To convey some idea of the magnitude of this area, it may be said that, regarded as an ancient lake bed, it is long enough and broad enough to engulf all England and to leave a broad margin all the way round.

The greater portion of this area is so deeply drift-covered, that it has been found inexpedient to sink through the covering in search of coal; hence, the seams are principally mined near the margin of the basin, and where streams have swept away the detrital materials. Professor Cox, in his "First Report on the Geology of Indiana," advanced the opinion that it is only around the rim or margin of the coal basin, and not throughout its central area, that we are to look for a succession of thick beds of coal; as though the luxuriant growth of plants, now consolidated into coal, took place in the shallow parts of the lake, while the deep and quiet waters were unfavorable to their growth and accumulation. While there are many facts which tend to support this hypothesis, it cannot be regarded as definitely settled.

Recurring, however, to the Indiana portion of the coal fields, it may be said that the assemblage of rocks—made up of coarse and fine-grained sandstones, limestones, shales, fire clays, kidney and banded iron ores—has a vertical thickness of about six hundred feet; and in this range are included not less than six seams of coal, more or less persistent, each having its own peculiarities in physical and chemical composition, and the whole presenting gradations all the way from fatty, caking coals, to those which are meagre, dry, and non-caking. Appended in a tabular form* is,

* Appendix, Table A.

in the main, Professor Cox's section of the Coal Measures of Indiana, as given in his First Report. I have modified it in reference to the thickness of the seams N and M, as displayed along the line indicated. I may remark that, in rocks made up of materials drifted into a lake basin by varying currents, there will be found great inequalities of thickness and great changes in lithological character. A parallel section made twenty or thirty miles further north or south, but slightly conforms to this table. The latest borings at Terre-Haute seem to indicate that the vertical distance between coals F and B is only about seventy feet; whereas, in the section, it is given as 263 feet. So, too, according to the boring in Sullivan County, given by Mr. Collett (Second Report), the vertical distance between the seams L and K is 272.6 feet; whereas, in the section, it is given as 30 feet.

The seams L and K are among the most persistent in the series, and range almost uninterruptedly through the entire coal-field. The former is rich in volatile materials, and in places, it is believed, will be found so far free from sulphur as to be fit for gas purposes, while the residuum may be used in the form of coke in the hot-blast furnace. The seam K is often semi-block in structure, is not disposed to cake, and, while it carries more or less sulphur, is a strong, free-burning coal, intrinsically as valuable for steam making and domestic purposes as the block coal.

Next in the descending order is seam I—the main block coal seam, or what is known as the Brazil or iron-smelting seam—whose product has already begun to exercise a marked influence upon the industrial pursuits of Indiana, and is destined to accomplish still grander results. Obscure traces of this seam have been observed by Professor Cox as far north as Warren County, but the point where it first becomes clearly defined is on Cole Creek, Fountain County (Kirkland's mine), near the intersection of the Indianapolis, Bloomington and Western Railroad with the Indiana North and South Railroad. The seam here is nearly four feet thick, and while it presents the peculiar block-like arrangement in all its perfection, it is more or less contaminated with sulphur. At several points in this vicinity outcroppings of this seam have been observed, but explorations have not been carried sufficiently far to develop its true character. Proceeding southward there succeeds

a drift-covered interval effectually concealing the subjacent rocks, and it is not until we arrive on the bank of Sugar Creek that they again become exposed. On one of its affluents (at Barker's mine) the seam is stripped and shows good coal, three and one-half feet thick. At Russell's, near the crossing at Wright's Mill, it is nearly four feet thick, strong in mixed carbon, but more or less sulphurous. Here it comes quite down to the Conglomerate. Crossing Sugar Creek, it is found to emerge on the west bank of Little Raccoon, at Buchanan's mine; and also on both sides of Sand Creek, where I could obtain no good exposure, the openings having tumbled in, but the seam is said to be four feet thick. Next succeeds another drift-covered interval, twelve miles in length, having traversed which we are brought to the region of Brazil. The seam here is from three and one-half to four and one-half feet thick. The peculiar qualities of the block coal were first discovered in this district, and within the short space of five years it has become the seat of an active mining and iron-smelting industry. The qualities here developed form the standard of comparison in all estimates of value for every outcrop throughout the entire range and extent of this seam. It is looked upon as typical of what an iron-smelting coal ought to be. The inhabitants of this district would fain believe that, during the Carboniferous Epoch, Divine Providence deposited this peculiar class of coals within a very circumscribed area, of which Brazil is the centre; but investigations lend no basis for this belief. Present explorations perhaps indicate that the southern part of Clay and the western part of Owen Counties are the most favored portion of the block coal range; but the geologist who would assume such explorations as conclusive, would be hasty in his generalizations. South of Brazil this seam attains its greatest thickness as well as its widest dimensions. In Parke County the zone is hardly three miles wide; in the region of Brazil it is about six miles wide; but in southern Clay and western Owen Counties it is nearly ten miles wide, and here the seam also appears of increased thickness, and while it is rarely less than four feet, it sometimes expands to five feet. It is in reference to the development of the seam as here displayed, that the Cincinnati and Terre-Haute Railway has been projected.

Approaching the northern boundary of Greene County, the

Conglomerate is found to curve abruptly into the Coal Measures, cutting off the range of the block coal, or rendering it difficult to be traced. At all events, adopting the results of Professor Cox, which I regard as eminently trustworthy, we here pass almost directly from the limestone seam K to the Conglomerate seam A. To account for this anomaly we must adopt one of two conclusions: Either that the Conglomerate formed an ancient shore line which interrupted the deposition of the block coal; or, that if deposited, the coal has been subsequently removed by drift agency. The detrital materials are here so abundant that this problem can only be solved by the aid of the diamond drill.

From the mouth of Eel River to the crossing of the Ohio and Mississippi Railroad, there is a gap of forty miles in which the block coal seam has not been recognized; but at the latter point it approaches the surface and shows a thickness of about three feet. Going south, the country becomes covered with detrital materials; and, while the limestone seam (K) is displayed as at Alfordsville, Portersville and Jasper, the subordinate seam is not detected before reaching the waters of Hunting Creek, in the eastern part of Spencer County. Here it is over three feet thick, and, in the purity of its contents, its compactness and its non-caking qualities, it will prove the most highly prized of all the iron-smelting coals of Indiana.

Subordinate to this coal seam is another in this vicinity, four feet thick, which is emphatically a splint coal that cannot be distinguished in its external characters from the Brookfield coal of the Mahoning Valley, so highly esteemed. Passing over the slight watershed between the Patoka and Crooked Creeks, the block coal seam occasionally crops out, but in diminished thickness; and, where it strikes the Ohio River, near Troy, it is found to have contracted to thirty inches, and although firm and glossy, it carries a notable percentage of sulphur.

Below the last described seam are two others, separated by a wide interval, and associated with the Conglomerate or heavy-bedded sandstone: B and A. The former rarely expands to over two feet in thickness, and, while it is valuable for neighborhood purposes by stripping along the line of its outcrop, it will not afford material for distant transportation. The seam A occasionally expands to a

workable thickness, is very dense, and gives a larger percentage of fixed carbon than the best Brazil coal, while it is equally free from deleterious ingredients.

These several seams may be approached by drifting or by shallow shafts. The dip of the including strata is very moderate, rarely exceeding twenty feet to the mile. Its direction is toward the southwest. The cost of mining is $1 a ton, and the miner, working eight hours a day, is enabled easily to take down in that time three tons.

To enable the scientific inquirer to judge of the comparative merits of the several seams of coal, and how far, in many instances, the same seam varies in quality, the assays of the principal coals are appended.*

TERRE-HAUTE, IND., Dec. 23, 1871.

No. III.

Character and Special Uses of Block Coal.

I now propose to discuss the physical and chemical properties of the block coals of Indiana, and their adaptation to the manufacture of the highest grades of bar iron and Bessemer steel.

The term "block," as descriptive of a peculiar class of coals, crept in an unscientific way into the geological vocabulary, but it has now become so firmly rooted that it must hereafter be recognized as legitimate. The physical characters of this class of coals are these: There are two systems of joints, traversing the seam perpendicularly, which cut the mass into quadrangular blocks two or three feet long and a foot or more broad; and the miner availing himself of these natural divisions, after having undermined the base, is able to pry out the blocks without a resort to gunpowder. He can easily take down three tons a day. These joints appear to have been formed after the materials entering into the structure of the coal were deposited, and are due to a force acting independently of that of consolidation. Where a

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* Appendix, Table B.

considerable area is laid bare by stripping the surface, the seam resembles a tesselated pavement. Viewed in section, the appearance is as though block upon block, each of uniform size, had been piled up by the hand of man. In entering the drifts, the zig-zag appearance reminds one of a Virginia fence. The sides of the block are smooth, of a dull bluish color, and are often stained white with fire-clay; but if cleft longitudinally, there is seen a mass of mineral charcoal so slightly cemented by bitumen that it readily crocks on handling. The blocks are splintery on cross-fracture, but longitudinally they come out in thin flat sheets like roofing slate. Such are the external characters of the coal near Brazil; but further south, in Spencer County, it is so far consolidated that it breaks longitudinally with a splintery fracture, and may be rubbed with a white handkerchief without communicating any crock.

This coal when thrown upon a fire, at once ignites with a crackling sound, and burns with a bright yellow flame, giving off little fuliginous matter. It is non-caking, or in other words does not run together, thus affording free air--passages. It is so far free from sulphur that it leaves behind a white or gray flocculent ash; and, subjected to the strongest drafts, it gives no clinker. Hence, it is an admirable coal for locomotives, by reason of its rapid combustion, its freedom from clinker, and its disposition not to form a hollow arch, which in the fatty coals must from time to time be broken up to give free air--passages. These qualities, too, insure the integrity of the grate bars. The coal is sufficiently firm to hold up the burden of a furnace, and the only inconvenience it offers is in the amount of "dust," or fine particles of mineral charcoal which are nearly incombustible. This inconvenience appertains to the coals at present used in the blast furnace, but would be absent in the more compressed coals before referred to. From careful assays it is ascertained that this class of coals gives from 57 to 62 per cent. of fixed carbon, a small amount of hygrometric moisture, and a small amount of ash, whose whitish and flocculent character would indicate the comparative absence of the bi-sulphuret of iron.

The Pittsburg coals differ very slightly in chemical composition from the block coals of Indiana, and yet we know that they

behave altogether differently in combustion.* The latter will make iron in a crude state, while the former require that the volatile materials be expelled, the residue being used in the form of coke. This difference is due, probably, to the mechanical texture of the coal rather than to its chemical composition. In the case of the block coals there are thin partitions of a cannel-like nature which prevent the cells filled with bitumen from coalescing and rendering the whole mass tumid.

That the volatile materials play an important part in the combustion of coal cannot at this day be denied. Formerly it was supposed that the heating power of coals was dependent on the amount of fixed carbon which they contained; but later investigations show that we must take into consideration the calorific power of hydrogen, carbon and sulphur, as well as the indirect influences of nitrogen, watery vapor and oxygen. To estimate the effects of all these ingredients, it is necessary that we possess ultimate analyses of our coals, but unfortunately this process has not been carried out sufficiently to afford us the means of extended comparison. This, however, may be confidently affirmed, that coals rich in volatile materials excel in evaporative power although they may fall below in elevation of temperature. The best block coals fall but a few degrees below pure charcoal in calorific intensity. So far as relates to the presence of the deleterious elements of sulphur and phosphorus in the block coals, little has been done by chemists to estimate the quantity. In fact, this remark will apply to most of the existing assays of coal in the United States. I requested Professor Delafontaine, a gentleman every way competent to enter upon this investigation, to apply the most delicate tests to the splint variety of the Brazil seam occurring in the western part of Spencer County, and specimens were selected from what is known as the Staab Mine for that purpose.

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* Wormley gives the following assays of (I) Youghiogheny, and (II) Briar Hill, Veatch's Mine, coals; the first being a caking, and the second a non-caking coal.

	Ash.	Moisture.	Volatile Matter.	Fixed Carbon.	
I.	3.45	0.90	28.90	66.85	=100
II.	1.45	2.47	31.83	64.25	=100

The assay of two specimens of this coal by the ordinary method gave the following results:

Water at 212° F.	1.86	3.91
Fixed carbon	58.26	62.81
Volatile matter	37.11	30.84
Ash, white	2.80	2.44

Two and one-half ounces of this coal were submitted to distillation in a closed vessel, with the following result:

Coke	63.05
Tar, approximatively	15.30
Water, ditto	15.11
Gas	5.97

The water contained ammonia and other soluble chemicals, besides a small amount of hydrosulphate of ammonia. The amount of phosphoric acid was 0.3, and the amount of sulphuric acid was 0.0.

Compared with the English coals of Pontypool, Bedwas, and Ebbw Vale, the amount of phosphoric acid was far greater in every instance; and while in the English coals there was a notable percentage of sulphur, in the Staab coal there was an entire absence. Comparing these results with the amount of phosphoric acid contained in the ashes of elm, oak and apple-tree wood, the result is, that while the Staab coal contains 0.3 per cent. of this deleterious ingredient, those woods contain all the way from 4.19 to 9.61 per cent. Thus it will be seen that there are coals in the Indiana field, which are freer from the element of phosphorus, so deleterious to iron making, than charcoal itself. The same rigorous tests ought to be extended to every portion of the Brazil seam.

These block coals, we know from experience, when tested in a blast furnace, have all the qualities of charcoal as a reducing agent. Two and a half tons of coal are required to make a ton of iron. The Brazil coals are not quite as strong in fixed carbon as the Mahoning or the Shenango coals, but they produce a more highly esteemed pig metal. What Mushet said in his great work on Iron, in reference to the best variety of Welsh coal, is applicable in every sense to the block coal of Indiana:

"To the purity of splint coal it unites all the softness and combustibility of wood, and the effects produced by it in the blast furnace, either as to the quality or quantity of iron, far exceed anything in the manufacture of that metal with charcoal."

Professor Cox, in charge of the Geological Survey of the State of Indiana, bears the following emphatic testimony as to the quality of these coals for iron smelting:

"Without fear of contradiction, I pronounce the block coal of Indiana the best mineral fuel yet known to the world for the manufacture of pig metal, bar iron or steel. In the blast furnaces, it produces a metal in every respect equal to the best charcoal iron made from the same ores. In the puddling furnace a less quantity of block coals is required than of the best Pittsburg Coals to make a run of bar or wrought iron. The bars are brought off in a shorter space of time and the quality of the iron is better. The gray pig iron, made with raw block coal, in Clay County, from a mixture of Lake Superior and Missouri hæmatite ores, is used with excellent results in the manufacture of Bessemer Steel at Chicago. Mr. Robinson, the Superintendent of the Union Rolling Mills there, writes that 'the Indiana coal seems to be just the thing for steel.'"

It is a significant fact, that the puddled iron made at Indianapolis from block coal pig, is employed at Pittsburg in forging gun barrels.

TERRE-HAUTE, December 12, 1871.

No. IV.

Terre-Haute and Wabash River.

The City of Terre-Haute derives its name from the high ground on which it is founded. The French voyageurs who gathered at Vincennes as far back as 1705, wandered up the Wabash and applied this name to an Indian village which was three miles south of the present town. The site is a beautiful one, being on a plateau about sixty feet above the river, sloping in every direction so as to admit of easy drainage, and the river may be made available to supply the inhabitants with an abundance of good water.

The town was organized in 1816, and the fact of its situation on the line of the Great National Road, a stupendous scheme in its day, and of which Henry Clay was the projector, gave to this place a prospective importance. What, however, led to its sub-

stantial growth was the completion, in 1852, of the Terre-Haute and Indianapolis Railroad, and the subsequent extension of that road to St. Louis, thus fixing Terre-Haute as an imporant point on one of the great thoroughfares of traffic between the seaboard and the Mississippi Valley, and at the same time rendering tributary for manufacturing purposes the block coal region of Brazil, lying sixteen miles to the east. Up to that time the population of Terre-Haute accumulated in thirty-five years, barely reached 4,000. In 1860 it had risen to 8,594; at the present time it is not far from 20,000, and is rapidly increasing. Since the completion of the Terre-Haute and Indianapolis Railroad there have been put in operation the following routes, which bear directly on the commerce of this city: The St. Louis; Vandalia and Terre-Haute; the St. Louis and Indianapolis, essentially a rival line running to the same principal points; the Evansville and Crawfordsville: and the Terre-Haute and Danville. Some miles are constructed of the Cincinnati and Terre-Haute Railway, to the stock of which the city has voted a subscription of $100,000, thus evincing her disposition to open new avenues of trade.

By these routes Terre-Haute has direct access to the Lakes, to the Ohio and Mississippi Rivers, and to the seaboard. She is distant from Chicago 180 miles; from St. Louis, 165; from Cincinnati, 180 miles, and from Louisville, 150 miles—the last two distances being computed by the Cincinnati and Terre-Haute route. Thus, then, it will be seen that there is room here for the growth of another inland city, and I know of no place which has stronger claims to assume such a position than Terre-Haute. She is surrounded by a country fertile almost beyond comparison, and much of it is clothed with a magnificent forest growth. The Wabash Valley has long been known as furnishing the best corn lands in the United States, and the uplands produce good Winter wheat. The forests yield abundant materials for railroad ties, and a great variety of hard-wood lumber, suitable for railway cars, wagon materials, coopers' materials and agricultural implements; nor are there wanting the ornamental woods, such as black walnut, cherry, ash and honey locust. The city is bedded on coal, which crops out both to the east and west, and sixteen miles eastward is the great block coal field. The union between the specular iron ores

of Missouri and Lake Superior and the block coals of Indiana can be effected here as cheaply as at any other point, and the Wabash River affords an unfailing supply of water for furnace and other manufacturing purposes. An iron furnace, under the superintendence of Mr. A. L. Crawford, with a daily capacity of turning out twenty-five tons of pig-metal, is already in successful operation. There is a rolling-mill, with a nail factory attached, with a capacity to manufacture 1,800 kegs of nails a week, and also a glass factory.

Main street is substantially built for the most part of brick, but the fronts of many buildings are of Ellettsville limestone, a free-cutting stone of an agreeable tint and great durability, and capable of any degree of ornamentation. It is, in fact, one of the most desirable stones for construction to be found in the United States. Many of the private residences, with their surrounding walks and shrubbery, indicate a spirit of taste and refinement on the part of their owners. The State Normal School is situated here, and the building, of brick, with stone trimmings, in the midst of a square, presents an attractive appearance. The Opera House and Dowling's Hall, both tastefully built and adorned, afford commodious quarters for popular amusements. The public school buildings are also worthy of commendation, and evince that the people are not neglectful of the interests of education. To the members of the American Association for the Advancement of Science, on the occasion of their visit to this place last Summer, the citizens extended a magnificent reception.

With regard to the importance of the Wabash River as a great artery of trade, I am not profoundly impressed. In early days it was a great channel of communication with the exterior world, when flat-boats and keel-boats were the principle vehicles of transportation. This stream, like the Ohio, each year, as its sources are cleared, and its swamps drained, appears to flow with diminished volume. A survey with reference to the improvement of its navigation has just been completed, under direction of the United States Topographical Bureau, and the plan contemplated is to remove the snags and sawyers, and excavate channels through the sand bars. This plan, while it might remove many impediments, would not increase, but rather diminish, the average depth of

water, by permitting it to flow more freely, and when completed would only admit of the free navigation of the river for a limited portion of the year by steamers of small capacity. To slack-water the river would be impracticable, for the intervales bordering the stream are broad, and large tracts of rich land now cultivated would be inundated and rendered valueless. The only feasible method to render the Wabash thoroughly navigable, is to imitate what is now doing in the neighboring State of Illinois—to start at the head of Lake Michigan, say Michigan City, and cut a canal at least one hundred feet broad on the bottom, to the northernmost bend of the Wabash, and use a portion of the waters of that great reservoir to keep the river in a boatable condition, except when closed by ice. There is a growing disposition on the part of the people to restrain Congress from embarking in schemes of internal improvement designed to benefit particular sections; but the State of Indiana is nearly out of debt, and may be disposed to execute a project which would redound so much to her prosperity. By this means a water communication far cheaper than any land conveyance might be maintained throughout the entire length of the State, a distance of more than two hundred and fifty miles in an air line; thus uniting the commerce of the Ohio and Mississippi Rivers with that of the Great Lakes.

TERRE-HAUTE, December 20, 1871.

No. V.

Growth of the Block Coal Region.

Six years ago, Brazil, Indiana, was an obscure station on the Indianapolis and Terre-Haute Railroad. A single shaft, ninety feet in depth, worked by a horse whim, supplied the neighborhood demand for coal. The behavior of this coal in combustion excited no particular remark. A small quantity found its way to the Indianapolis Rolling Mill, where it was observed by some explorers from the Mahoning Valley, Ohio, who recognized its similarity in external characters to the most highly prized coals of Northern Ohio, and inquired as to the source from which it was obtained. Being informed, they at once entered upon its explora-

tion. Lands were leased or purchased; capital flowed in; an active industry sprang up. The result now is that there are six blast furnaces in operation,* using raw coal alone, which are capable of turning out fifty thousand tons of pig metal annually; and more than twenty collieries, raising 3,565 tons of coal daily, giving employment to nearly a thousand men and freighting fifteen railroad trains.† The demand for this peculiar coal is insatiable, and far outstrips the mining development or the railroad facilities for its transportation. I cite this as a notable example to show how far peculiar local resources are capable of originating and maintaining great lines of traffic.

The Cincinnati and Terre-Haute Railway, now constructing, will cross the block coal zone where it attains its widest expansion, and where the seam exhibits its greatest thickness. This territory embraces the southern part of Clay County and the western part of Owen. The seam is from four to four and one-half feet in thickness, and at one point it is five and one-half feet. Chemically, it is as rich in fixed carbon, and affords as white and flocculent an ash, as the best Brazil coal. I append two assays by Prof. Delafontaine :

	Oberhaltzer's Mine.	Wagstaff's Mine.
Water at 212° F.	0.80	2.17
Volatile matter.	34.20	39.63
Fixed carbon.	61.35	56.79
Ash, white and flocculent.	3.65	1.41
	100.00	100.00

In the Oberhaltzer Mine there is a sulphur band in the middle, which is easily separable. Five feet thickness of coal was visible when I saw the seam, and an additional foot, it was said, was concealed by water. The territory underlaid by the block coal immediately adjacent to the line of the railroad, or which can be reached by short branches, comprises a little more than three townships. Admitting that one-third of the area originally occupied by this seam has been swept away by drift agency, there remain nearly fifty thousand acres of four-feet coal, capable of

* Appendix, Table C.

† Appendix, Table D.

yielding about six thousand tons to the acre, or an average of three hundred million tons.

Although the explorations in the northern part of the coal-field would indicate that the block coal seam wedges out rapidly when traced towards the interior of the basin, yet that is a question which cannot be considered as solved. Judging from the explorations in other countries, and particularly in England, we have a right to expect that this seam will continue in nearly undiminished thickness as it is found to pass under the overlapping edges of the superior strata. If so, as the dip is very moderate—less than twenty feet a mile, to the southwest—the area over which this seam can be mined at moderate depths will be found to be greatly enlarged. A more careful investigation of the materials brought up in the recent borings at Terre-Haute would indicate that the block coal seam, in increased thickness, passes beneath that city—an indication totally at variance with the observations of those who sank the first wells. A problem upon which hinges such important economical considerations should ere long be solved beyond a doubt.

The Brazil seam (the seam I of Professor Cox's classification) does not represent all the iron-smelting coals of this region. There is evidence of other seams which come in as lenticular masses. At Brazil, which is about twelve miles north of the line of the Cincinnati and Terre-Haute Railway, since the organization of the State Geological Survey, there has been discovered another seam, twelve feet below I, four feet thick, having all the properties of a first class smelting coal, which is successfully used in a crude state in the blast furnace. At Centre Point, about five miles north of the line of the projected railway, twenty-eight feet below the seam I, there is another seam, four and one-half feet thick, which on exploration will probably be found to yield a first-class coal. These two seams are the equivalents of G and F of Professor Cox's classification.

Still beneath is another workable seam of coal, included in the Conglomerate or heavy-bedded sandstone, and designated as Seam A. At Arney's Mine it is three feet thick; the coal is clean to handle, splintery in its fracture, and glossy and jet-like in appearance. Chemically, it is rich in fixed carbon, and contains

a small amount of ash of a white and flocculent character. It should be tested as a smelting coal. The following is the assay:

Water at 212° F.	6.99
Volatile matter	28.99
Fixed carbon	62.28
Ash	1.74
	100.00

Above the Brazil seam there are two others which will prove of great economical value. (1) The seam K—in limestone—is exposed at Middlebury, Linton and other points, where it appears from four and one-half to five feet in thickness. This is one of the most persistent seams in the Indiana coal-field, and yields a coal semi-block in character, and whose evaporative power probably will be found to be as great as that of the Brazil seam. It is well adapted for steam-making and domestic purposes. (2) The seam L is the thickest in the series, and probably the most persistent. It seldom is less than five feet in thickness, and occasionally extends to nine. It underlies nearly the whole of Sullivan County, and is extensively mined at Curryville, Shelburn and other points, and the products are sent to the Chicago market. In many of the exposures there are clay partings of half an inch or more, which would indicate that it is a compound seam, and each bend on assay will be found to present distinctive chemical characters. Much of this coal is free-caking and rich in volatile materials. Wilson's coal, belonging to this seam, and near the line of the Cincinnati and Terre-Haute Railway, assayed as follows (Cox):

Gas	45.25
Water	2.35
Fixed carbon	51.60
Ash, white	0.80
	100.00

Prof. Cox remarks: "This is one of the best caking coals that has come under my notice in the State. It is of a glossy, jet-black color, vitreous fracture, and will soil the hands little more than cannel coal. The ash is white, and does not amount to

one per cent. The coke is of a fair quality, and the gas is 6.1 per cent. greater than I found in a sample of the best gas coal from Pittsburg."

A rich gas coal which shall yield a good firm coke free from sulphur is a great desideratum. In the Scotch district, where the splint coals are used to reduce the iron ores, it is found that the addition of a certain percentage of coke enables the furnace to carry a heavier blast, and consequently increases the yield in pig metal. The same experiments have been successfully tried in the Mahoning Valley, at Chicago and at St. Louis. The West Coast furnaces (England), run with Durham coke, turn out from forty to eighty tons daily, while those of Brazil do not exceed twenty-five tons. To transport coke from Sullivan County to the block coal region would not require a distance of over twenty miles to be traversed.

The Cincinnati and Terre-Haute Railway, then, in a distance of thirty miles, will intersect not less than five seams of workable coals, which have an aggregate thickness of not far from twenty-five feet. These coals will be found to vary all the way from fatty, caking coals, rich in gas and capable of yielding a firm coke, to dry, non-adhesive coals, having all the qualities of charcoal. The construction of such a line must develop a great mining and manufacturing industry, in the opening of numerous collieries for the supply of home and distant markets, and the erection of furnaces, Bessemer works, rolling mills, foundries and machine shops. White and Eel Rivers will afford an unfailing supply of water for furnace and other manufacturing purposes—a requisite in which Brazil is deficient. Near their junction it may be expected then that another Brazil will arise, but bearing another name—the name of BESSEMER.

INDIANAPOLIS, January 13, 1872.

No. VI.

The Future Seat of Iron Manufacture.

There is no region of the earth where the ores of iron are so bountifully distributed, and in such a state of purity, as on the

water-shed between Lake Michigan and Lake Superior, and in the Iron Mountain region of Missouri. Practically the deposits are inexhaustible, and so far as relates to the purity of the ores, the chemist's art has thus far failed to detect a notable percentage of sulphur, phosphorus, titanium, or other noxious ingredient. The bulk of the ores occur under two forms: the specular or peroxide, containing 69.34 per cent. of iron, and the magnetic or protoxide, yielding 72.41 per cent. Even the specular ores contain disseminated crystals of magnetic oxide, thus giving a larger percentage of iron than is required by the formula for this mineral. In the practical working in the furnace they yield about 65 per cent of iron, thus showing that they contain only 4 or 5 per cent. of silica. This silica, even where in excess, is no detriment to the pig iron when employed in the Bessemer process, but is in fact an advantage.

Comparing these ores with those of the most important mines of Sweden *e. g.*, Dannemora, Persberg, Nara, etc., we find there that sulphur is so far present that it must be expelled by careful calcination—a process to which our specular ores are never subjected—and the matrix is generally highly silicious from the presence of free silica, so that the average yield of the ores is 50 per cent. The magnetite from which the famous India "wootz" steel is made, is said to contain 40 per cent of silica. It is from the magnetic and specular ores alone that the malleable iron is made in Sweden for exportation. Charcoal from wood of an indifferent quality, such as pine, larch and birch, gathered over wide spaces in midwinter, when the lakes and streams are frozen, is the only fuel employed in the reduction of the ores; and hence Swedish pig, apart from its intrinsic excellence, must always command a high price in the markets of the world. Russian pig iron can undergo no diminution of price, for the supply is limited, since a ukase of the Czar prohibits the felling of wood beyond an extent equal to the annual growth.

These details show that the Lake Superior and Missouri ores are to be preferred to those of Sweden in their freedom from sulphur, requiring no calcination, and in their greater freedom from silicious matter—there being a difference in their favor of not less than 15 per cent. In addition to these ores there are in both dis-

tricts large deposits of brown hæmatites (hydrated sesquioxides), yielding 59.89 per cent of iron, which are just the ores required for admixture with the specular and magnetic ores, and which are equally free from noxious ingredients; they are, in fact, the result of the decomposition of the former ores, taking into their composition 14.44 per cent. of water. Manganesiferous ores, also, occur in the Lake Superior district, and will be found, I have reason to believe, abundantly in Missouri and Arkansas. This class of ores is absolutely essential to the production of that pig iron known as spiegeleisen, or specular iron—a pig metal which breaks into large, bright, mirror-like facets, due to the presence of about 4 per cent. of manganese, and on which the Bessemer process of steel-making depends for its success.

After the opening of the Lake Superior Mines the iron-masters of Northern Ohio and Western Pennsylvania soon found that it was more economical to use a pure and rich ore from a distance than a lean and impure ore from the immediate vicinity of their furnaces; and the consequence is that the iron-ore traffic of Lake Superior within the last ten years has grown to prodigious proportions—the product in 1861 being only about 54,500 gross tons, while in the season just closed it reached nearly 1,000,000 tons. The growth in the traffic of the Iron Mountain ores of Missouri has been also very marked. The war of the Rebellion operated as a check on their mining; but since the peace the traffic has been rapidly extending, and next year, I am assured by Mr. Chouteau, the product will reach 350,000 tons. Thus, then, the ores derived from these two sources about equal in furnace yield the entire product in pig metal of the United States for the year 1861—a noteworthy fact in the development of the iron industry of this country.

The furnaces in the Mahoning Valley of Ohio, in the Shenango Valley of Pennsylvania, and at Pittsburg, Buffalo, Cleveland, Massillon, Dover, Toledo, Detroit and Brazil, are the principal consumers of the Lake Superior ores. At Buffalo the anthracite coals from Pittston are used for their reduction: at Pittsburg the iron-masters employ not only the coal in their vicinity, but that on the Connelsville road, sixty miles distant, both of which must be reduced to coke before being used; in the Mahoning and

Shenango Valleys and at Massillon they obtain a coal which is employed in a crude state for iron-smelting; at Cleveland they use coke obtained from the region of Pittsburg; at Toledo and Detroit they largely use charcoal; and at Brazil they use coal in a crude state. In the Lake Superior region there are ten hot-blast furnaces where charcoal is exclusively employed. Coke undoubtedly is among the best of reducing agents, but in the process of coking the volatile materials are not economized. According to experience in England the coals lose one-fourth in weight, while they gain one-fourth in bulk. The cost of the process is probably from a cent and one-half to two cents a bushel. To maintain perpetually a charcoal furnace requires at least 10,000 acres of land. Charcoal furnaces, then, can never exist in close proximity, as they soon disrobe a country of its forests. Block coal is the cheapest and most available fuel in iron metallurgy. Now, if we consult a map on which are indicated the ore deposits and the deposits of fossil fuel, as well as the several routes of transportation, both natural and artificial, we shall find that bringing the iron ores and the coal together, for the manufacture of iron, can be effected more cheaply within the outline of the block coal region of Indiana than at any other point.

And, first, as to the distribution of the Lake Superior ores. I will take, for example, Pittsburg and Terre-Haute as connecting points. Adopting Escanaba, on the northern shore of Lake Michigan, as the common point of departure for these ores, there is a lake voyage of five hundred and eighty-five miles to Cleveland, which involves two towages, one through the St. Clair River and Flats, and one through the Detroit River into Lake Erie; the transportation costing ordinarily $3 per ton. To convey these ores to Pittsburg involves a railroad transportation of one hundred and fifty miles, at a cost of $2, together with a transfer and dockage charge of 25 cents, making the entire cost $5.25. From Escanaba to Chicago is two hundred and seventy-five miles, and a vessel may lay a straight course between the two points. Mr. W. B. Ogden, one of the most practical and sagacious business men of the Northwest, who conveys his lumber from Peshtigo to Chicago in barges built ship-shape and calculated to resist heavy seas, maintains that in this way the iron ores can be transported from Escanaba

to Chicago for $1 per ton. Estimating the railroad transportation at a cent and one-third per ton per mile, and the cost of transfer the same as at Cleveland, these ores ought to be delivered at Terre-Haute, one hundred and eighty miles from Chicago, at $3.65 a ton, or a difference on the whole route, as compared with Pittsburg, of $1.60 a ton. Now, in a furnace turning out twenty-five tons of pig metal a day, requiring 33.75 tons of ore, this difference in the cost would amount to nearly $20,000 per annum—a very pretty dividend. If it be said that Terre-Haute is sixteen miles from the coal, on the other hand it may be said that Pittsburg is sixty miles from the coke.

I now come to the distribution of the Iron Mountain ores, again taking Pittsburg and Terre-Haute as the connecting points, and St. Louis as the point of departure. To Terre-Haute, by rail, the distance is one hundred and sixty-five miles; to Pittsburg, six hundred and thirty-five miles. Estimating the transportation at a cent and one-third per ton per mile, the cost of delivering a ton of ore at Terre-Haute would be $2.20, which the iron-master can afford to pay; and to Pittsburg $8.46, which the iron-master cannot afford to pay.

Under certain favorable circumstances, where Pittsburg operators send their barges laden with coal to St. Louis and bring back ore, the transportation has been effected at $3 per ton. It involves a voyage of not less than 1,200 miles, and can be performed only during the Spring and Fall freshets of the Ohio River. The same ores can be brought into union with the block coals of Southern Indiana by a water communication seven hundred miles less in extent. It should be borne in mind, too, that there is a market on the western slope of the Mississippi Valley for all the iron and steel which can be produced in the coal-field of Indiana for many years, and Terre-Haute is nearly five hundred miles nearer that market than Pittsburg. With the best crude materials at command, the iron-master of Indiana, exercising a reasonable skill, ought to be able to defy competition.

INDIANAPOLIS, Jan. 20, 1872.

No. VII.

British Ores Failing.

Every geological observer who investigates the distribution of the coals and iron ores of our country, and the facilities which exist for bringing them together, must, I think, arrive at the conclusion that, before the lapse of another generation, the United States will be the great iron and steel-producing country of the world.

Great Britain is now at the head of the iron interest of the world, having some six hundred furnaces, which annually consume upward of 11,500,000 tons of ore, and bring out a product in pig metal of 5,500,000 tons, valued at over £13,500,000 sterling. This production is only about two and three-fourth times that of the United States; and in going back a single decade, we find that in Great Britain the rate of increase has been only about 44 per cent., while in the United States the rate has been at least 120 per cent. There are causes in operation which will prevent any rapid expansion of the iron industry in the one country, while in the other the great sources of that industry are comparatively untouched. Among these causes may be mentioned the limited supply of good ores in Great Britain, and the necessity which arises each year of sinking deeper for the fuel to smelt them, and, consequently, the increased expense of raising it to-day. Great Britain has a redundancy of capital content with moderate earnings, which the United States has not; but each year tends to equalize the disparity. She has not an unlimited supply of cheap labor to draw upon, and any sudden expansion of her iron industry would raise the price of wages. In fact, the cheap labor of France and Belgium even now compels England to rely on her superior skill for her manufacturing ascendancy. The great body of the British ore is derived from the Coal Measures and the Lias. There are four great iron centers in the Kingdom, viz.: The South Wales, the Scotch, the Cleveland and the West Coast districts. In the South Wales and Scotch districts the impure carbonates of the Coal Measures are very largely used, and the yield in metallic iron ranges from 21 to 34 per cent. Owing to the great demand for pure pig, suitable for the Bessemer process, foreign

ores are brought into the South Wales district from Belfast and Spain, which are intermixed with a brown hæmatite from Llantrissant, and reduced with raw coal. In the Scotch district occurs the famous black-band ore of Mushet, which gives a furnace yield of about 40 per cent. Splint coal in a raw state is the reducing agent. The pig metal, a dark gray iron, though not adapted to the Bessemer process, has a high reputation in the markets of the world.

The industry of the Cleveland district has within a short time shown an unexampled growth, and now furnishes nearly one-third of the pig iron produced in the United Kingdom. The ores are derived from the Lias, which crops out in bold cliffs on the Yorkshire coast. They are lean, giving only from 30 to 35 per cent. in the furnace, and they abound in the worst of impurities, the pig iron itself retaining not less than 1.33 per cent. of phosphorus. The product of the furnaces is worked into railroad bars and ship-plates. The Durham coke, an excellent article, is near at hand, which makes the reduction of these inferior ores profitable. Now, if we turn to Percy's great work on the "Metallurgy of (British) Iron," where the assays of one hundred specimens of these ores are given, we shall find that in every instance he detected the presence of phosphorus, and while the average amount reached .63 per cent., in some instances it went up to 1.12. No metallurgic skill has thus far been able to eliminate this deleterious ingredient from the ores, or prevent it from passing into pig iron; nor is it wholly extirpated from the manufactured bar. In the Bessemer process it adheres to the iron, in every stage and in undiminished quantity. With one per cent. of phosphorus, iron becomes fit for but few purposes. Sulphur is also present in these ores, which is to some extent expelled by calcination and the subsequent process of puddling, but sufficient remains to render the iron unfit for conversion into the higher qualities of steel. These noxious ingredients appertain to the Coal Measure ores the world over, as though the organic matter which formed the coal, charged with these substances, communicated them to the iron ores.

In the districts of Dartmoor and Devonshire there are limited deposits of magnetites, but they contain about two per cent. of phosphorus, which renders them nearly worthless, except for bombs and coarse castings.

Owing to the success of the Bessemer process, the West Coast district has rapidly risen in importance within the last ten years. The ores which here occur are the best in the Kingdom, but the fuel to smelt them is not readily accessible. They are the only British ores adapted to bringing out good Bessemer pig; and since this fact has been demonstrated, the number of furnaces in the district has increased from nine to thirty-six. The geological position of these ores is in the sub-carboniferous limestone, and they occur in the form of pockets, occupying the fissures and cavities, and, therefore, are not persistent in range. At Cleator Moor, Cumberland, a compact, pulverulent, unctuous ore is obtained, yielding 66 per cent., and free from noxious ingredients; at Lindale Moor and Ulverstone, Lancashire, a hard, compact, red hæmatite is obtained, yielding 65 per cent. of metallic iron, and of an excellent quality. These ores contain a notable percentage of silica, which is essential to Bessemer pig; and yet to get rid of the excess, and to make a more fusible slag, an aluminous ore from Belfast, Ireland, is used for admixture. So great is the demand for these hæmatite ores, that within two years the price has been advanced 50 and even 70 per cent., and the product of the mines is contracted for up to 1873. The supply is inadequate, and British iron-masters have organized two stock companies of large capital to import a high grade of ores from the distant region of Spain. In Great Britain these peculiar ores occupy a circumscribed area, and, it is feared, may give out altogether. At the Edinburgh meeting of the British Association for the Advancement of Science, two years ago, it was proposed to raise a committee to memorialize the Director of the Geological Survey, that he cause investigation to be made to determine whether this class of ores might not be found to occupy a larger area; and more recently the Iron and Steel Institute have preferred a similar request, but thus far no favorable response has been given. The fuel employed in the reduction of these ores is Durham coke, which is brought one hundred and twenty miles by rail.

Another significant fact, showing the deficiency of England in ores suitable for the higher qualities of steel, is this: that, notwithstanding she is the largest exporter of iron in different forms, she is at the same time a very considerable importer of Swedish

and Russian pig metal, made from specular and magnetic ores, similar in composition to those of Lake Superior and Missouri, that are used by the iron-masters of Indiana for ordinary purposes. A Sheffield steel manufacturer will pay £30 a ton for this iron, when ordinary British pig can be had at one-fifth or one-sixth of the price. These importations often reach as high as 50,000 tons of pig metal a year, while the importation of foreign ores is not less than 2,000,000 tons.

Here are considerations which ought to arrest the attention of American statesmen and political economists in reference to the future growth and grandeur of our country. I have endeavored to show, in my former letters to The Tribune, that in Indiana there is a vast body of fossil fuel, which has all the merits of charcoal as a reducing agent; that in Missouri and on the borders of Lake Superior are large deposits of iron ore, free from noxious ingredients, and eminently adapted to the production of the highest grades of iron and Bessemer steel, and that the natural and artificial communications are such that the union between the coal and iron can be effected as cheaply as in any region of the earth.

INDIANAPOLIS, Jan. 22, 1872.

No. VIII.

Iron Industry of the Northwest.

The States northwest of the Ohio River, and embraced in the provisions of the Ordinance of 1787, show a development in population unprecedented in the annals of the human race. The bulk of population, and consequently the scepter of political power, within the memory of living men, have passed from the Atlantic coast to beyond the Alleghanies. The political divisions carved out of this area had already acquired the appellation of the "Food-Producing States," but now they are rapidly assuming the position of mining and manufacturing commonwealths. While in a purely agricultural community there are no extremes in the distribution of wealth, neither great opulence nor abject poverty, still, such a community, deprived of home markets and subjected to heavy

exactions upon every article sent abroad or received at home, is not in a condition to embark in those schemes of improvement which are characteristic of our modern civilization. For the full development of a State there must be a diversified industry. Those who manufacture the crude materials add quite as much to the national wealth as those who produce such materials, whether derived from the soil, the forest or the sea. Where there exists the happy combination of a fertile soil and a genial climate, agriculture is at first the leading pursuit; but as population increases, as men gather in communities and routes of intercommunication are opened, there follow manufactures and the mechanic arts. The Northwestern States have already entered upon this second stage of development. Selecting iron, its mining and manufacture, as an example of diversified industry, the progress of development within the past ten years exhibits the most gratifying results. Referring to the statistics of Mr. Henry McAllister, Jr., Secretary of the American Iron and Steel Association, recently published, that industry may be traced from small beginnings up to the present time, when it has assumed commanding proportions.

ILLINOIS.

The first rails were rolled in 1858.

	Tons.
Rails rolled in 1871	40,026
Rails re-rolled in 1871	51,152
Total	91,178

Of the former, 2,800 tons were steel.

The first pig iron was made in 1854. In 1871 the product of seven furnaces was 65,000 tons. As a producer of railroad iron Illinois is now second only to Pennsylvania. In Chicago and vicinity before the lapse of another year, there will be in operation altogether, three Bessemer works, each with a double plant, six furnaces and four rolling mills, as well as numerous foundries and machine shops.

INDIANA.

A small quantity of charcoal iron, the product of three or four cheaply-constructed furnaces, no longer used, was made prior to 1860. Recently there have sprung up at Brazil and vicinity six furnaces using raw coal and capable of turning out 50,000 tons of pig metal annually. There is a rolling mill at Terre-Haute, at Greencastle, and at Indianapolis, and the amount of rails rolled in 1871 was 12,778 tons.

MICHIGAN.

		Tons.
In 1854 the first pig iron was made, amounting only to		900
In 1871 the product amounted to		100,000
Rails rolled		14,000
In 1856 the amount of ore raised was only		2,810
In 1871 the ore exported reached	810,984	
In 1871 the ore consumed reached	100,000	
Total		910,984

The value of the ores thus far raised in the magnetic region, delivered on the dock, is $35,185,778. The ores from this source, estimated at the furnace yield of 66 per cent., are now furnishing about one-third of all the pig iron produced in the United States. To show the prodigious growth of this industry, it may be stated that in 1861 the product of this region only reached 50,882 tons.

WISCONSIN.

	Tons.
In 1856 the first pig iron was produced	2,500
In 1871 the product was	28,249
Rails rolled	28,774

Several furnaces are projected, and the probabilities now are that an iron district will be developed on the Menominee and on the borders of Lake Superior, which, in the quantity and purity of its ores, will rival that of Marquette.

MISSOURI.

Although this State is not embraced in those comprehended in the Ordinance of 1787, yet she is closely linked by a community of interests with the Northwest. She is making rapid strides not only in mining the ores but in the product of pig metal and the manufactured bar.

	Tons.
In 1854 she produced in pigs	5,789
In 1871 she produced in pigs	82,685

of which 39,634 tons were smelted with charcoal and 42,751 tons with mineral coal.

In 1871 the rails rolled amounted to 8,200 tons. The capacity of the rolling mill at St. Louis, which went into operation late in the year, is 50,000 tons per annum. The shipments of iron ore from Iron Mountain and vicinity in 862 did not exeeed 2,000 tons; in 1871 they amounted to 268,800 tons. Mr. Chouteau informs me that this year the shipments from the Iron Mountain (specular ore) will reach 350,000 tons, while those from Cuba, west of St Louis (brown hæmatite), will exceed 25,000 tons.

Now, these States are producing about 20 per cent. of all the rails rolled and 40 per cent. of all the pig metal annually pro-

duced in the United States. Some of them now, and all of them hereafter, must draw, wholly or in part, their supply of fossil fuel from the coal-field of Indiana. Thus, as this industry extends itself, there will be created a need for the block coals, compared with which the present demand is insignificant.

CHICAGO, Feb. 14, 1872.

No. IX.

The Markets of Block Coal.*

The production of coal in the United States during 1871, as estimated by Mr. Sherman in a late speech in the Senate, was 34,000,000 tons, divided as follows: anthracite, 19,000,000; bituminous, 15,000,000.

The anthracites reach the Ohio Valley only in limited quantities, so that the main consumption for domestic and manufacturing purposes is of the bituminous varieties. The great mining center for the latter class of coals is Pittsburg. There were received there during the past year, 96,739,135 bushels of coal, or more than 3,700,000 net tons; and there were shipped down the Ohio River 47,298,000 bushels, or over 1,400,000 tons. But this amount does not represent all the shipments by river. Wheeling, Pomeroy, the Kanawha regions and other localities, swell the shipments, so that the amount which passes the Cincinnati and Newport Bridge, each year, for the supply of Cincinnati and the lower markets, is estimated at 75,000,000 bushels or over 2,800,000 net tons. Cincinnati last year, according to Mr. Hubbel, absorbed 30,000,000 bushels, over 1,000,000 tons, two-thirds of which were consumed in the city, and one-third was sent to the neighboring villages. The price of this coal in barges is 15 cents a bushel, or $3.95 a net ton. As the great bulk of the inhabitants cannot afford to buy their year's supply of fuel in the spring, but purchase as the necessity arises, this sum by no means represents the actual cost to the consumer. During the past winter, twice that price was demanded and paid. The precarious nature

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* Appendix, Table H.

of the river navigation must render the Cincinnati coal market subject to the most violent fluctuations. The middle men who carry stocks during the summer must gauge their prices in proportion to the uncertainty of their business. If the expected Winter freshet is delayed a few weeks, they become heavy losers. Now a railroad connecting Cincinnati directly with the Block Coal Field of Indiana, and constructed with express reference to a coal traffic, would enable that city to receive her supply of fuel at all seasons of the year, cheaper than she can otherwise in the most favorable stages of river navigation. Cincinnati and vicinity are nominally paying four and one-third million dollars for their yearly supply of fuel, but the difference between this sum and what is actually paid by the consumers in two years, would build a railroad to the Block Coal Field.

Turning now to the great Lake market—Chicago—it may be stated that the receipts of coal for 1871, were 1,081,472 gross tons, one-third of which was anthracite. In this market "famine prices" always prevail, which have seriously retarded manufacturing development. In the summer the price of anthracite is $9 a ton net, and in the latter stages of winter it rises to $13. The block coals of Northern Ohio generally open at $8 and close at $10, and at Brazil the prices fluctuate from $7 to $8. In analyzing the sources of supply, leaving out half a million of tons received by lake, it will be found that about 330,000 tons are drawn from the Illinois coal-field, less than 50,000 tons from the Brazil district, and nearly 190,000 tons from the Hocking Valley and the region of Pittsburg.

Now, with the opening of new collieries in the block coal district, and new lines of transportation to the Lake markets, which shall rely on the magnitude of their business, rather than exorbitant charges for their profits, the block coals of Indiana can be furnished to the Chicago consumer at $4.50 a ton; a consummation devoutly to be wished. At that price the Chicago market would yearly absorb half a million tons, and a quarter of a million tons would find their way to the neighboring villages. If Cincinnati can afford to build one railroad to the block coal region, Chicago can afford two.

In the markets of the Lower Mississippi, the block coals could obtain almost a monopoly, shipped as they can be from a point seven hundred miles below Pittsburg, and where the navigation is rarely impeded by low water or running ice.

I have previously shown how far the iron industry of the Northwest is tributary to block coal. The furnaces, rail-mills, Bessemer works and foundries, which within a very few years will go into operation, added to those already at work, together with the rapidly increasing demand for steam and household purposes, will cause the annual consumption of this peculiar coal ere long to reach many millions of tons. The construction of the Cincinnati and Terre-Haute Railway will duplicate the existing facilities for obtaining it.

CHICAGO, April 18, 1872.

No. X.

American Bessemer Steel Rails.

Some fifteen years ago, Mr. Bessemer, an English gentleman of German descent, conceived the idea of converting pig iron into steel without the intermediate processes of puddling or cementation. Eminent metallurgists, among whom may be named Percy and Noad, regarded his process, even after it had been reduced to practice, with extreme distrust; but now, every one must look upon it as a magnificent triumph—a triumph which goes very far to answer the world's demand for cheap steel.

The principle which the Bessemer process is founded upon, consists in forcing jets of air into a mass of molten metal, by which it is decarbonized without the further application of heat, while at the same time there is introduced another mass of molten metal sufficiently charged with carbon to convert the combined product into steel. The *modus operandi* is this: Pig iron is melted in an ordinary air-furnace, from which it is drawn into a "converter"—an ellipsoid vessel, capable of holding, say, five tons, constructed of wrought iron and mounted on trunnions. The interior is lined with fire brick, or with ground quartz cemented with fire-clay, and

the bottom is pierced with innumerable holes in the nature of tweers. When the blast of cold air is applied, instead of chilling the mass, as might be supposed before experiment, there is produced a glowing white heat, far more intense than that of a blast furnace; a violent ebullition ensues, and jets of molten metal are projected high in air, accompanied by a fierce flame, first violet, then orange, and last white, which indicates to the operator that the process of decarbonization has been carried sufficiently far. Colored glasses and even the spectroscope have been used in determining the precise point when to shut off the blast; but the skilled operator, looking not at the flame, but the reflected light on the wall, determines the matter without adventitious aids. The blowing process occupies from ten to twenty minutes. Then, tapping a small cupola furnace, there is allowed to flow thence from five to ten per cent of spiegeleisen, previously reduced, which almost immediately incorporates itself with the mass, which is then drawn off and cast into ingot molds.

This is the simple process for making Bessemer steel. A word as to spiegeleisen—glittering iron—upon which this process depends for its success. It is a pig metal, smelted from a manganesiferous iron ore, which occurs near Stahlburg, Germany, and has the peculiar property of breaking into large, bright, mirror-like facets. Its chemical composition, according to Schafhäult, is as follows:

Iron	88.961
Carbon	5.440
Manganese	4.003
Silicon	0.179
Nitrogen	1.200
Copper	0.166
Tin	0.116
Total	100.065

A later assay made by Fresenius, of a spiegeleisen run from the spathic ores at Musen, gives 20.7 of manganese, while the amount of carbon is only 4.3. The principal merit of this pig metal is its property of retaining a notable percentage of carbon and manganese. The franklinite of New Jersey—a tri-compound of iron, manganese and zinc—has this property in a still higher degree, as indicated by the assay of Henry:

Carbon	6.900
Silicon	0.100
Manganese	11.500
Sulphur	0.137
Iron by difference	81.363
Total	100.000

The red oxide of zinc in the franklinite, is regarded as no detriment, but rather as an advantage. Manganesiferous ores, probably suitable for spiegeleisen, as I have shown, exist both on the borders of Lake Superior and in Missouri, so that we shall not be dependent on foreign sources for this all-important ingredient in the Bessemer process.

Simple and wonderful as are these results, they represent chemical changes which have long been known. Pig metal, apart from its impurities, is a highly carbureted iron, the maximum of carbon which Faraday could obtain being 5.64 per cent. Steel contains from 0.3 to 1.3 per cent of carbon. Bar iron is steel freed from nearly every trace of carbon. Now it is evident that in the conversion of cast-iron into malleable iron it must pass through the intermediate state of steel; but the difficulty has been to determine the precise point of time at which to arrest the process. Bessemer (and herein consists the great merit of this process) adds the amount of carbon to the decarbonized iron requisite to form particular grades of steel; and so completely is this under the control of the operator that, in the practical working, it does not vary one-tenth of one per cent. While thus the amount of carbon necessary to produce the different grades of steel is susceptible of the nicest gradation, there are other elements which set at defiance the highest metallurgic skill; *e. g.*, phosphorus and sulphur. In the ordinary process of puddling, these noxious ingredients are, to some extent, eliminated; but in the Bessemer process, while the amount of sulphur is slightly reduced, the phosphorus passes into the steel in undiminished quantity, in fact increased in proportion to the loss sustained in the conversion. This is shown in the subjoined assay by Percy of pig iron and malleable iron, as determined by the Bessemer process:

	Pig Iron.	Malleable Iron.
Sulphur	0.485	0,402
Phosphorus	1.012	1.402

The Bessemer process has communicated an extraordinary impulse to the steel industry of England. There are now not less than twenty establishments using this process, which produce nearly 1,000,000 tons of this peculiar steel. The great bulk of the British ores, derived from the Coal Measures and the Lias, and the Pennsylvania ores, derived from the Coal Measures, as shown in a former letter, as well as the recent deposits known as "bog ores," are utterly worthless for the production of Bessemer steel. The Adirondack ores—and herein I include their extension southward to New Jersey—are often contaminated with sulphur and phosphorus, and even titanium—the latter element being equally deleterious—so that they cannot be employed where a high degree of tensile strength, as in iron, or keen cutting qualities as in steel, are required. Happily for us, however, in the specular and magnetic ores of Lake Superior and Missouri, and their resultant products from decomposition—the brown sesquioxides—we have an absolute perfection of iron ores, and in exhaustless quantities; and in the block coals of Indiana we have a reducing agent which closely assimilates to charcoal, thus providing the two great materials for the perfect realization of this problem.

As, then, the Bessemer process is destined to confer substantial benefits on mankind, and as our country affords unsurpassed facilities for its full development, I deem it opportune to state how far it has become domiciled among us, and what expense attends its introduction. The plant necessary to produce 100 tons of ingots in a period of twenty-four hours, costs $300,000, and to duplicate this plant under the same shelter costs $200,000. A rail-mill to consume this combined product costs $300,000. Thus to carry on the various processes from the crude metal to the merchantable rail, requires a capital of not less than $800,000. This sum may seem startling, but while capital is cautious, it is ever keen to seek the most profitable investments. Bessemer works have already been established at the following points: Troy, N.Y.; Johnstown, Harrisburg, and Bethlehem, Penn.; Cleveland, two establishments; Chicago, two; and Joliet, one now erecting. Each of these establishments has a double plant, and is capable of supplying a rail mill. At Troy, the melt consists of two-thirds English pig and one-third American charcoal pig. At Harrisburg and Bethle-

hem, anthracite iron, without the addition of charcoal iron, is employed. At Cleveland, pig iron from Missouri Iron Mountain ore, smelted with Brazil coal; and at Chicago, Brazil pig and Grand Tower pig, made from Missouri ores, reduced from a mixture of Murfreesboro' coal two-thirds and coke one-third, are successfully used. Mr. Holley prefers, however, in all cases, an admixture of one-third charcoal pig. The distinctive qualities of pig metal, whether made from specular or hæmatite ores, are disregarded, the main feature being their freedom from sulphur and phosphorus. The cost of spiegeleisen from Germany is $58, gold; that of the New Jersey franklinite, about the same. The latter is richer in manganese, and is equally esteemed. In the purchase of spiegeleisen, that containing ten per cent. of manganese is regarded as the standard; and the price is enhanced or diminished as the percentage rises or falls below that standard.

There is a loss of 14 or 15 per cent. of pig metal in the conversion into steel. The scraps are utilized by drawing them into merchant bars, ties, wire, etc. Where the cost of pig is $30 a ton, ingot steel is $61, and rails $81. For these practical details I am indebted to Mr. A. L. Holley, a gentleman of eminent experience, and under whose supervision several of the works enumerated have been erected. This branch of iron industry is yet in its infancy, especially in the States bordering the Ohio Valley. The cardinal fact is now demonstrated in the daily product of blast furnaces and converters, that the specular ores of Lake Superior and Missouri, by reason of their richness and purity, and the block coals of Indiana in their near approach to charcoal as a reducing agent, and the facilities which exist for bringing these together, are destined to answer the world's imperative demand for cheap steel. It requires no prophetic vision to foresee that, before the lapse of half a century, the block coal region of Indiana will be the principal seat of Bessemer steel manufacture, not only of this country, but of the world.

CHICAGO, March 11, 1872.

No. XI.

Ohio River Navigation.

The credit of the discovery of the Upper Ohio is probably due to La Salle. There is an interval in the life of that intrepid explorer, between the years 1669 and 1671, in which his career is but obscurely traced; but his admirers claim that, during this interval, he visited the region of Onondaga, New York, where, obtaining an Indian guide, he passed over to a branch of the Ohio, and, threading its course to the main affluent, he descended as far at least as the Falls below Louisville, when, his guide deserting him, he was compelled to retrace his steps alone. On the earliest maps the Ohio is called the Ouaboukigou—corrupted into Ouabache (Wabash)—the meaning of which is unknown; but this name is now applied to one of its principal tributaries, which traverses, in a south-westerly direction, nearly the whole State of Indiana. The early French voyageurs called the Ohio "La Belle Riviere"—The Beautiful River. The name Ohio, according to Heckewalder, the Moravian missionary, is derived from the Indian word Ohiopekhanne, signifying a very white stream, perhaps in reference to the white caps which diversify its usually placid surface when ruffled by a strong wind; but subsequent explorers found it convenient to drop the three ultimate syllables for ease of pronunciation. It is, indeed, a beautiful stream; not that its waters are pure and crystal-like, but the hills which border the intervales have a rounded outline and are covered with a forest verdure so diversified as at once to arrest the attention of the tourist. The area of its basin is not less than 214,000 square miles; and the first settlement of English extraction within this basin was made since the birth of men now living.

There has been a development of material wealth in this region unsurpassed in the previous annals of the human race. The great cities of Pittsburg, Cincinnati and Louisville have been founded upon its banks, and a restless, energetic people have established homes upon its remotest tributaries. In the early days of colonization the Ohio was the great artery of communication with the outside world. During the winter, flat-boats—broad horns—were

constructed on the banks of the principal tributaries, and as soon as the icy fetters were unloosed, were launched and loaded, and, availing themselves of the spring freshets, pursued their way to the distant market of New Orleans. This, indeed, was the only market. In the course of time came railroads, which have wrought an entire change in the commerce of the country, and rendered the navigation of the Ohio of secondary importance, at least so far as relates to the movement of passengers and of those articles which possess a concentrated value. Eighty years of settlement have also essentially changed the character of the river itself. As the sources of its feeders become disrobed of their forests, and the low grounds drained for the purposes of cultivation, the spring freshets carry off at once the superabundant waters, and there succeed long intervals in which the navigation of the main river is practically suspended. Old residents upon its banks wonder why it no longer moves with a nearly equable flow. A mysterious power is apparently operating to change its regimen. This is due to physical causes easily comprehended. Trees with their leafy canopy not only condense the floating vapors, causing them to descend in fertilizing showers, but also retard the circulation of the atmosphere, and consequently prevent evaporation. Swamps are nothing more than great sponges placed at the heads of streams, capable of absorbing large bodies of water, slowly to be given off. Now, when you fell the trees and drain the swamps over a river basin, the river itself will no longer move with a nearly equable flood. And such is the case with the Ohio.

The hydraulics of this stream are given by Humphreys and Abbot, in their great work upon "The Physics of the Mississippi Valley;" and that I may not lay myself under the imputation of misrepresenting the precariousness of its navigation, I will condense their statements. The Ohio, formed by the junction of the Monongahela and Alleghany, is nine hundred and seventy-five miles in length. With the exception of the "Falls" at Louisville, where it descends twenty-six feet in three miles, it flows throughout its entire course with a gentle current. Its bars, particularly in its lower course, are composed of shifting sands; and this fact is memorable to every one who, like myself, has been repeatedly

"stuck" upon them at different points, all the way from Pittsburg to Scuffletown Rapids. Its range between low and high water is about 45 feet. Its least low-water depth on the bars, from the mouth to Paducah, is about 3.0 feet; thence to Louisville, 1.5 feet; thence to Cincinnati, 2.0 feet; and thence to Wheeling, 1.0 foot. My early recollections of the navigation of this stream, before the days of the telegraph, are these: The captain of a river steamer fitted to run on a "heavy dew," would moor his craft on the river bank and plant a shingle at the shore line and watch the rising of the waters to determine whether it were safe to proceed. This shingle formed, in fact, a water-gauge, and a rise of two inches diffused joy among the passengers, a prelude of what was to come. The Nilometer is not more intently watched by the dusky Egyptian than was that shingle by us, a fair-haired race. No one, except from experience, can form an idea of the irksome listlessness, the utter disgust which fell upon the unfortunate passenger, who for days was compelled to remain aboard an Ohio steamer, tied up to the bank or "stuck" on a sand bar. The *brevia et syrtes* encountered by the Trojan fleet were far less formidable than the shoals and quicksands encountered by the Ohio pilot in low water.

In February, on the breaking up of the winter, the first rise usually occurs, which is ten or fifteen feet greater than any other. The average spring rise is about twenty-five feet at the mouth, and high water continues for six weeks. The next rise, the smallest of the three, is in May or June, and is due to the summer rains, and lasts at Cairo three or four weeks, and one or two weeks at Louisville. Next is the autumnal rise, commencing in November, which, however, is not to be depended upon. The river is always low in October—at a time when the inhabitants along its borders wish to lay in their winter's supply of coal. In August and September it is only navigable for boats of eighteen inches draught. It freezes about Christmas and sometimes remains frozen for a month. The usual succession of stages is this: January, river frozen; February, breaking up and high; March, high; April, high: May, falls somewhat; June, rises again; July, falls and is low; August, is very low; September, very low; October, very low; November, rises; December, well up.

These facts, compiled by the Topographical Bureau, show that between the summer's drouth and the winter's ice, there is an interval of only about three months in which the Ohio is navigable for coal-barges drawing seven feet of water. To remedy these defects several plans have been suggested. Long ago Mr Ellet, an engineer of considerable reputation, proposed to construct a series of reservoirs at the head of the principal streams, in which to collect the surplus water, and dole it out as necessity might require; but this plan has never been seriously entertained. The Government from time to time has made appropriation for the improvement of the navigation, and the plan adopted has been to put in wing dams at the head of the more formidable bars, and thereby deepen the current; but this has proved a mere makeshift, the effect being merely to tear out the loose sands at one point so as to enable them to accumulate at another. As an all-comprehensive measure, it has been proposed to slack-water the entire river, and vague estimates have been made of the cost. Without considering the damage which such a plan would inflict upon the farming land on the banks of a stream subject to such great fluctuations, a convocation of Pittsburgh steamboat men solemnly resolved that the cost would not exceed that of the construction of the Union Pacific Railroad. Mr. Ellet's plan of constructing reservoirs would cost $60,000,000, and Col. Haup's of dams and pools, $42,000,000. Now, this is all very pleasant to contemplate, if we are assured that Uncle Sam will foot the bills; but there is a power behind the throne, and that power is the people. They have more than once evinced a disposition not to make appropriations which shall inure solely to a particular district. All the expense of the permanent improvement of the Ohio, I apprehend, will devolve on its bordering States.

The cost of transportation in flood time on the Ohio, for bulky articles like coal laden in barges, is far less than by any land conveyance. While railway transportation reaches a cent and a third per ton per mile, river transportation is less than three mills per ton per mile. Unfortunately, as has been shown, there are long intervals during which navigation is practically suspended. I was infomed by a friend who was at Newburgh (on the Lower Ohio) last September, that for nine months not a coal barge had

passed that point. The precariousness of this navigation subjects the coal markets of Cincinnati and Louisville to violent fluctuations. If the autumnal rise of the waters is delayed a few weeks, or fails to come before the ice sets in, there ensues a coal "famine," and the supply has to be drawn from distant points and at exorbitant prices. Last autumn the price of coal in the Cincinnati market was 36 cents a bushel; in the Louisville market, 32 cents. At this time it is respectively 28 and 26 cents. Now, it is confidently claimed that if both these cities were connected by direct lines of railway with the block coal region of Indiana, they would be furnished with an abundant supply of fuel adapted to all steam, domestic and smelting purposes, at cheaper rates than prevail at this time. These markets would not be subject to violent and ruinous fluctuations Such a line of communication will be afforded by the construction of the Cincinnati and Terre-Haute Railway. The distance from the coal-field to Cincinnati is one hundred and forty miles, to Louisville one hundred and ten miles. Estimating the cost of mining at $1 per ton, and transportation at a cent and one-third per ton per mile, and 50 cents as the profit of the mine owner, block coal ought to be delivered on the car in the Cincinnati market at $3.36 a ton, or less than 13 cents a bushel; and in the Louisville market at $3 a ton.

INDIANAPOLIS, Feb. 22, 1872.

XII.

General Review—The Prospect.

I here bring to a close my remarks upon the coal and iron resources of the Northwest. These exist in a region where the soil is fertile and the climate healthful, and where the rapidity of development in population and material wealth has no parallel in the previous annals of the human race. Coal and iron, it may be confidently affirmed, rest at the base of our modern civilization. It is by their union that man has been able to acquire a mastery over nature, and to subject her forces to his will. In the steam engine, perhaps, we have the most important example of this

union. How much each year it adds to the world's wealth! To how vast an extent it displaces the expenditure of human muscle, performing a giant's labor with more than a giant's strength, and yet with a precision and certainty unattainable by human hands! It enables us to traverse the ocean and the land with a speed unknown to our ancestors; and in our machine shops and factories day by day, it is silently performing labors equivalent to those of many millions of men. The union of coal and iron in their application to the various arts, is the mainspring of the progress of every dominant nation. We need no better index of the prosperity of a people, of their high state of civilization, than is furnished by the amount of iron which they annually consume.

The Northwest has hitherto been preëminent as an agricultural region. A new era is now dawning upon it. Capitalized wealth, which builds railroads, which opens mines, which erects furnaces, factories and machine shops, and which transforms crude materials into objects fitted for the comforts and refinements of life, is now rapidly flowing into this region, as the most favored in the United States. Here, within the lapse of another generation, astonishing changes will be wrought; and, in the impulsive power communicated to this great industrial movement, the BLOCK COALS OF INDIANA will be found to play an important part.

CHICAGO, April 20, 1872.

APPENDIX.

Section of Coal Measures, - - - - Table A

Assays of Indiana Coals, - - - - - " B

Blast Furnaces in Clay County, - - - C

Indiana Block Coal Mines, - - - - - " D

" Caking Coal " - - - - " E

Distances, Cincinnati and Terre-Haute Railway, - - " F

" from Cincinnati to St. Louis, - - - " G

" of Markets, - - - - - " H

Map of Block Coal Region and its Railway Connections.

[TABLE A.]

Connected Section of the Coal Measures of Indiana

ALONG THE LINE OF THE

CINCINNATI AND TERRE-HAUTE RAILWAY.

FEET.		
43½		
		Coal **N**; thin, not workable.
31⅓		
		Coal **M**; " " "
30		
5		Coal **L**; very persistent.
14½		
5		Coal **K**; " " "
14½		
		Coal **J**; mere streak.
11		
4		Coal **I**; Main Block.
12½		
		Coal **H**; mere streak.
25		
4		Coal **G**; not persistent, but sometimes expands to a workable thickness. Block-like in structure.
24		
4		Coal **F**; characters similar to G.
263		Heavy beds of sandstone — "Millstone Grit;" rarely containing pebbles.
2		Coal **B**; rarely workable.
20		
3		Coal **A**; often workable.
512⅓		**Total.....25 feet of workable Coal.**

[TABLE B.]

ASSAYS OF THE PRINCIPAL COALS OF INDIANA.

SEAM.	DESIGNATION.	WATER AT 200° F.	FIXED CARBON.	VOLATILE MATTER.	ASHES.	COLOR.
L	SPENCER COUNTY—					
	* Knob	4·30	61·65	31·16	2·98	Gray.
L	DAVIESS COUNTY—					
	* Wilson's	0·00	59·69	34·17	6·14	Reddish.
L	SULLIVAN COUNTY—					
	† Wilson's	3·00	52·00	43·00	2·00	White.
	† Hanna's	5·00	54·00	38·50	2·50	Gray.
K	FOUNTAIN COUNTY—					
	† Thomas's	3.00	59·80	32·70	4·50	Brown.
	* Orahood's	7·52	56.33	29·88	6·27	Gray.
	* Townley's	4·70	52·36	32·03	10·91	Red.
	* Myers's	2·02	55·57	38·37	7·04	Red.
K	PARKE COUNTY—					
	* Kyle's	3·27	58·04	30·03	8·66	Red.
	† Batty's	3.00	56·00	38·50	2·50	White.
	* Beale's	3·88	57·15	35·86	3·11	Reddish.
I	FOUNTAIN COUNTY—					
	† Kirkland's	6·65	57·55	33·83	2·06	Gray.
I	PARKE COUNTY—					
	* Barker's	2·37	57·21	37·42	3·00	Gray.

* Coals assayed by Prof. Delafontaine, at request of Dr. Foster.
† Coals assayed by Prof. Cox, and assays contained in his reports.

SEAM.	DESIGNATION.	WATER AT 200° F.	FIXED CARBON.	VOLATILE MATTER.	ASHES.	COLOR.
	* Russell's	0·80	61·07	32·46	5·67	Gray.
	* Silliman's	1·32	58·15	36·53	4·00	Gray.
	† Buchanan's	4·20	62·50	31·00	2·00	White.
I	Clay County—					
	† Barner's	4·00	57·00	37·50	1·50	White.
	† Garlick and Collins'	8·50	57·50	31·00	3·00	Lead.
	† Knightsville	9·00	59·80	30·90	0·30	White.
	† McClelland's	5·00	54·70	38·80	1·50	White.
	† Star	3·50	61·50	32·50	2·50	White.
	* Stedman's	2·00	61·69	30·57	6·14	Gray.
	* Wagstaff's	2·17	56·79	39·63	1·41	White.
I	Owen County—					
	* Oberhaltzer's	0·80	61·35	34·20	3·65	White.
I	Daviess County—					
	* Clarke's	0·00	53·08	36·80	15·90	White.
	† Clarke's	4·50	57·30	34·70	3·50	White.
I	Spencer County—					
	* Staab's	1·86	58·23	37·11	2·80	White.
	* Staab's	8·11	58·28	29·57	4·04	Yellow.
	† Staab's	1·80	54·00	42·60	1·60	White.
G	Clay County—					
	† Carbon Coal Co's	3·40	55·25	39·85	1·50	White.
	† Garlick and Collins'	2·75	57·90	35·85	3·50	White.
	† Garlick and Collins'	2·10	57·95	37·35	2·60	White.

* Coals assayed by Prof. Delafontaine, at request of Dr. Foster.
† Coals assayed by Prof. Cox, and assays contained in his reports.

[TABLE C.]

BLAST-FURNACES IN CLAY COUNTY, INDIANA.

NAME OF FURNACE.	Location.	Hot or Cold Blast.	Year Built.	Cost of Construction.	Capital Stock.	Height of Furnace.	Diameter of Boshes.	Diameter of Hearth.	Diameter of Tunnel Head.	Daily Consumption of Fuel.	Daily Consumption of Ore.	Daily Consumption of Limestone.	Daily Yield of Pig Iron.	Number of Men employed.
						FEET.	FEET.	FEET.	FEET.	TONS.	TONS.	TONS.	TONS.	
Brazil.....	Brazil.....	H. B.	1867	$150,000	$250,000	60	14	5	6	70	45	16	28	150
Lafayette.....	"	H. B.	1869	70,000	80,000	45	10½	4	5	45	37½	10	18	30
(2 stacks.) Knightsville...	Knightsville	H. B.	1867 1868	160,000	.....	50	12	6	4½	100	60	24	45	.....
Planet.....	Harmony...	H. B.	1867	.....	.....	40	10½	4	.....	40	25	10	15	.....
Vigo.....	Terre Haute	H. B.	.....	.....	.....	50	12	.....	.....	.....	.....	.....	20	.....

[TABLE D.]

INDIANA BLOCK COAL.

Details of Mines now Working.

	Capacity in Tons per Day.	Mining now in Tons per Day.	Number of Men employed.
Garlick & Collins	600	250	80
Niblock, Zimmerman & Alexander	1000	500	100
Otter Creek Coal Company	450	300	75
Indiana Coal Company	600	400	80
Star Mine	300	200	40
Gartsherry & Co.	300	200	50
J. W. McClelland & Co.	200	150	30
Clay County Coal Company	380	300	80
Weaver Coal Company	120	100	20
Butch, Dixon & Andrews	125	100	25
Brazil Block Coal Company	200	150	30
Ormsby Coal Company	150	100	25
Veach Coal Company (new)	.....	75	20
Bartlett Coal Company	120	100	20
Great Western Coal and Mining Company	.....	50	20
Morrison & Woodruff	120	100	20
Morris Coal Company	.....	80	25
Strain's mine	.....	30	10
Armstrong's mine	.....	50	15
Robert Guest	.....	30	10
Total at Brazil	4665	3265	775
CARBON STATION.			
Carbon Coal Company	300	200	40
Clay County Coal Company	200	100	20
Total at Brazil and Carbon	5165	3565	835

NOTE.—Daily shipment from Brazil at present is 171 cars, which is not half the number the demand calls for.

[TABLE E.]

CAKING COALS MINED IN BRAZIL DISTRICT.

Collated November, 1871.

	Tons.	Tons.	Men.
Great Western Coal Company	800	500	100
Greencastle Coal Company	120	100	20
Bailey Coal Company	300	250	50
Bartlett Coal Company	400	300	60
Webster Mining Company (new)	80	50	10
Williams Mining Company (new)	80	50	10
Six other Mines—names not given	700	600	120
Total Brazil caking coals	2480	1850	370
Mined in Davies County (caking)	1200	800	180
Total	3480	2650	550

[Table F.]

CINCINNATI AND TERRE-HAUTE RAILWAY.

Distances—Main Line.

	MILES.
Cincinnati to State Line	19.5
State Line to Greensburg, Ind	37.4
Greensburg to Columbus, "	24.6
Columbus to Bloomington, "	37.7
Bloomington to Bessemer, "	22.4
Bessemer to Terre-Haute, "	40.3

Branches.

Bessemer to Merom	39.5
Lateral Branches	78.1
Main line and branches, 280 miles being in the State of Indiana, and 19½ in the State of Ohio	299.5

[Table G.]

DISTANCES FROM CINCINNATI TO ST. LOUIS.

	MILES.
Via Indianapolis and St. Louis Railroad	376
" St. Louis, Vandalia, Terre-Haute and Indianapolis Railroad	353
" Ohio and Mississippi Railroad	340
" Cincinnati and Terre-Haute Railroad	328

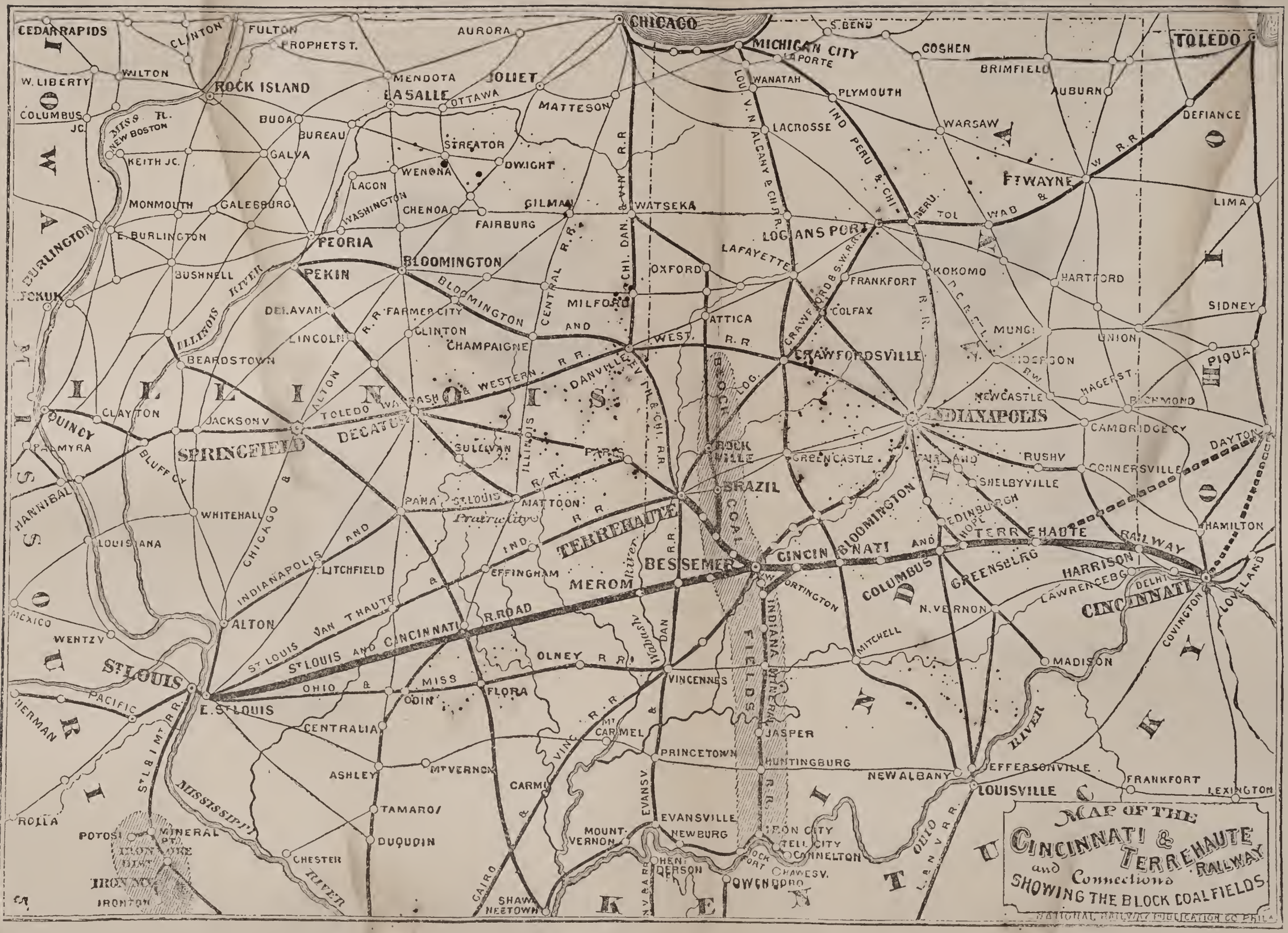
[Table H.]

DISTANCES OF MARKETS

In an Air Line from Bessemer.

	MILES.
To Louisville	100
" Cincinnati	130
" Chicago	175
" Toledo	230
" Sandusky	260
" Cleveland	316
" Detroit	275
" Nashville	200

	MILES.
To St. Louis	175
" Cairo	180
" Keokuk	240
" Hannibal	225
" Rock Island	230
" Indianapolis	60
" Terre-Haute	30
" Evansville	90


CHICAGO
CEDARRAPIDS
CLINTON
FULTON
PROPHETS T.
AURORA
S. BEND
MICHIGAN CITY
LA PORTE
GOSHEN
TOLEDO
BRIMFIELD
WILTON
W. LIBERTY
ROCK ISLAND
MENDOTA
JOLIET
LASALLE
OTTAWA
MATTESON
WANATAH
PLYMOUTH
AUBURN
COLUMBUS JC.
MISS R.
NEW BOSTON
BUDA
BUREAU
LACROSSE
WARSAW
DEFIANCE
KEITH JC.
GALVA
STREATOR
DWIGHT
WENONA
LACON
FT WAYNE
LIMA
MONMOUTH
GALESBURG
WASHINGTON
CHENOA
GILMAN
WATSEKA
FAIRBURG
LOGANSPORT
BURLINGTON
E. BURLINGTON
PEORIA
BLOOMINGTON
LAFAYETTE
OXFORD
KOKOMO
HARTFORD
BUSHNELL
PEKIN
FRANKFORT
FARMER CITY
DELAVAN
MILFORD
ATTICA
COLFAX
SIDNEY
LINCOLN
CLINTON
CHAMPAIGNE
MUNCIE
UNION
BEARDSTOWN
CRAWFORDSVILLE
PIQUA
NEWCASTLE
HAGERST.
RICHMOND
QUINCY
CLAYTON
JACKSONV.
DECATUR
SPRINGFIELD
INDIANAPOLIS
CAMBRIDGE CY
DAYTON
P. MYRA
SULLIVAN
ROCKVILLE
GREENCASTLE
RUSHV.
CONNERSVILLE
HANNIBAL
PANA
ST. LOUIS
MATTOON
Prairie City
BRAZIL
SHELBYVILLE
WHITEHALL
LOUISIANA
LITCHFIELD
EFFINGHAM
MEROM
BESSEMER
CINCINNATI
COLUMBUS
GREENSBURG
HARRISON
HAMILTON
MEXICO
WENTZV.
ALTON
N. VERNON
CINCINNATI
MITCHELL
OLNEY
MADISON
ST. LOUIS
VINCENNES
FLORA
ODIN
E. ST. LOUIS
CENTRALIA
JASPER
PRINCETOWN
HUNTINGBURG
NEW ALBANY
JEFFERSONVILLE
FRANKFORT
LEXINGTON
LOUISVILLE
ROLLA
ASHLEY
MT. VERNON
TAMAROA
DUQUOIN
EVANSVILLE
NEWBURG
IRON CITY
BELL CITY
CONNELTON
POTOSI
MINERAL PT.
IRONTON
CHESTER
HENDERSON
OWENSBRO
SHAWNEETOWN
MAP OF THE
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SHOWING THE BLOCK COALFIELDS
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